EXECUTIVE SUMMARY

When Congress authorized construction of the Trinity River Division (TRD) of the Central Valley Project (CVP) in 1955, the expectation was that surplus water could be exported to the Central Valley without harm to the fish and wildlife resources of the Trinity River. The TRD began operations in 1963, diverting up to 90 percent of the Trinity River's average annual yield at Lewiston, California. Access to 109 river miles of fish habitat and replenishment of coarse sediment from upstream river segments were permanently eliminated by Lewiston and Trinity Dams. Within a decade of completing the TRD, the adverse biological and geomorphic responses to TRD operations were obvious. Riverine habitats below Lewiston Dam degraded and salmon and steelhead populations noticeably declined.

In 1981, the Secretary of the Interior (Secretary) directed that a Trinity River Flow Evaluation (TRFE) study be conducted to determine how to restore the fishery resources of the Trinity River. This report is the product of that TRFE study. It provides recommendations to the Secretary to fulfill fish and wildlife protection mandates of the 1955 Act of Congress that authorized the construction of the Trinity River Division of the Central Valley Project, the 1981 Secretarial Decision that directed the U.S. Fish and Wildlife Service to conduct the TRFE, the 1984 Trinity River Basin Fish and Wildlife Management Act, the 1991 Secretarial Decision on Trinity River Flows, the 1992 Central Valley Project Improvement Act, and Federal Tribal trust responsibilities.

This report was compiled by teams of experts. After research and literature reviews were completed, they met to discuss the collective implications of their work. Individual chapters were then written and reviewed as a group. The purpose of each chapter was to:

- describe Congressional, Secretarial, and other actions taken to address the declines of the Trinity River fishery resources (Chapters 1 and 2);
- present the pre- and post-TRD biological and physical scientific knowledge of the Trinity River, including salmon and steelhead life histories and population trends, and changes in channel morphology and overall quality of fish habitat (Chapters 3 and 4);
- present the findings of studies conducted as part of the TRFE and the Trinity River Fish and Wildlife Restoration Program (Chapter 5);
- evaluate the effectiveness of the water volumes identified in the 1981 Secretarial Decision to restore fishery resources (Chapter 6).

The collective scientific effort led to:

- the conclusion that a modified flow regime, a reconfigured channel, and strategy for sediment management are necessary to have a functioning alluvial river (mixed-size rock, gravel, and sand deposited by river flow) that will provide the diverse habitats required to restore and maintain the fishery resources of the Trinity River (Chapter 7);
- instream flow, channel-rehabilitation, and fine and coarse sediment recommendations to address this conclusion (Chapter 8); and
- a recommendation to utilize an Adaptive Environmental Assessment and Management (AEAM) approach to guide future management and ensure the restoration and maintenance of the fishery resources of the Trinity River (Chapter 8).

Life History and Physical Requirements

The life histories of steelhead (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*), and chinook salmon (*O. tshawytscha*) have two distinct phases, one in freshwater and the other in salt water. These species lay their eggs (spawn), hatch, and rear in freshwater. The adults lay their eggs in gravel of various preferred sizes (depending on species). The eggs incubate in the spaces between rocks of the river bed. After a period of time, small, fully formed fish ("fry") emerge from the gravel to begin their free-swimming life-stages. Young salmonids remain in the river of their birth for months to years (depending on species) before migrating to the ocean. Before they migrate, they undergo a physiological transformation (called smoltification) that allows them to survive in a saltwater environment. At that point, they are called "smolts". After the transformation, they migrate to saltwater. Salmon grow to their adult size in the ocean, returning in 2 to 5 years to the river of their birth to spawn.

Steelhead, coho salmon, and chinook salmon each require similar instream habitats for spawning, egg incubation, and rearing, although there are important differences. Timing of these habitat needs varies, thus optimizing population numbers and survival by minimizing competition among species. Common life-history requirements for these species include spawning gravels relatively free of fine sediments, adequate spawning habitat, low-velocity shelters for early life-stages, adequate rearing and feeding habitats with cover from predators, and appropriate flows and temperature conditions for migration to and from the ocean. For all species, spawning occurs in tails of pools and riffles where gravels are cleansed of fine sediment by high flows. Eggs and embryonic life stages develop in these well-percolated gravels for weeks until emerging as fry, which seek shallow, low-velocity shelters usually found along channel margins of gently sloping point bars and backwater areas. As they grow, habitat requirements change to faster and deeper riffle, pool, and run habitats, depending on the species. The habitats necessary for salmonids to complete all of their freshwater life stages were provided in the pre-TRD riverine environment; however, these conditions were radically changed by the operations of the TRD.

Changes of Riverine Habitats and Fish Populations Resulting from Construction and Operation of the TRD

Prior to the construction of the TRD, the Trinity River was an unregulated, meandering, dynamic alluvial river within a broad floodplain. Alluvial means "material deposited by running water." Dynamic means "that the alluvial material was frequently moved and the channel moved back and forth across the floodplain over time". Alluvial rivers are often characterized by a repeated, distinctive S-shaped channel pattern that is free to meander in the floodplain (alternate bar sequences). High flows periodically changed the size, shape, and location of river bars (submerged or exposed alluvial material). Flow regulation by the TRD removed nearly all high flows that were responsible for forming and maintaining dynamic alternate bar sequences. No longer scoured by winter floods downstream of the TRD, streambank (riparian) vegetation encroached into the river channel and formed riparian berms along the channel margins. Reduced flows, loss of coarse sediment, and riparian encroachment caused the mainstem river downstream from the TRD to change from a series of alternating riffles and deep pools that provided high-quality salmonid habitat to a largely monotypic run habitat confined between riparian berms (a trapezoid-shaped channel). The loss of alluvial features and diverse riverine habitats reduced the quantity and quality of salmonid habitats and the populations that relied upon them.

The available data indicate that in-river spawning populations of salmon and steelhead have dramatically declined since the construction of the TRD (Table ES1). Average spawning numbers of post-TRD naturally produced spring-run (return to the river in the spring) and fall-run (return to the river in the fall) chinook salmon represent a 68 percent reduction compared to the pre-TRD average. Large numbers of returning chinook salmon spawners observed since 1978 were typically hatchery-produced fish. Naturally produced fall- and spring-run chinook salmon account for an average of 44% and 32% of their respective spawning runs. This situation is not indicative of healthy spawning and (or) rearing conditions for naturally produced populations. The inriver coho salmon spawning population is predominantly of hatchery origin, with only 3 percent of the spawning coho attributable to natural production. While naturally produced fall-run steelhead make up a large portion of the inriver spawners (70 percent), this still represents a 53 percent reduction from pre-TRD estimates.

Table ES1. Pre- and Post-TRD Adult Salmon Returning to Spawn

Species	Pre-TRD Average[1]	Post-TRD Average for Naturally Produced Spawners[1]	Percent Reduction
Chinook Salmon (Spring-Run/Fall-Run)	38,600[2] (not available)	12,550 (1,550/11,000)	68%
Coho Salmon	5,000	200	96%
Steelhead	10,000	4,700	53%

[1] Pre- and Post-TRD adult salmon return data is presented in Chapter 3.
[2] Pre-TRD average number of chinook salmon returning to spawn was reduced by 9,000 to make pre- and post-TRD numbers more comparable, (i.e. the fish production that previously was provided above Lewiston and is included in the pre-TRD average of 47,600 chinook is now provided by the TRFH (returning adult requirements to provide eggs for the hatchery are 3,000 spring-run chinook and 6,000 fall-run chinook)).

Coho salmon that return to Klamath and Trinity Rivers are considered by the National Marine Fisheries Service (NMFS) to be part of the Southern Oregon/Northern California Coast Evolutionary Significant Unit (ESU) — one population for Federal Endangered Species Act (ESA) purposes. This ESU has been listed as threatened pursuant to the ESA. The final rule that listed the ESU recognized that various habitat declines affected coho salmon populations, including channel morphology changes, substrate changes, loss of off-channel rearing habitats, declines in water quality, and altered streamflows. The steelhead and chinook salmon populations of the Trinity River are being evaluated pursuant to the ESA and may warrant listing in the future.

Although the primary focus of this report is salmon and steelhead, pre-TRD wildlife populations have also been affected by changes in the riverine environment. Wildlife habitat features such as seasonally flooded marshes and side channels, shallow river margins, cold-water holding pools, and bank undercuts have been reduced or eliminated owing to TRD operations. Species that depend on flood-maintained habitats, such as the foothill yellow-legged frog (*Rana boylii*) and the western pond turtle (*Clemmys marmorata*), have been negatively impacted by TRD construction and operations.

Flow Evaluation Studies and Results

Several individual studies provided the needed information to make the recommendations in this report: (1) habitat preferences of salmon and steelhead and relative amounts of preferred habitats resulting from varying dam releases; (2) an evaluation of habitat availability and channel processes at channel-rehabilitation projects; (3) water and sediment interactions and river channel shape (fluvial geomorpholgy); (4) water temperature needs of salmon and steelhead and dam releases necessary to meet those needs; and (5) a juvenile salmon production model. The results of these studies are summarized below.

A study of the physical conditions (such as water depth, velocity, and structural elements) that support specific anadromous salmonid life stages (microhabitat) resulted in the development of site-specific habitat suitability criteria. Using these criteria, the relationships between microhabitat and streamflow for riverine life-stages of chinook salmon, coho salmon, and steelhead were modeled. Results of physical habitat availability modeling on the Trinity River were used as a partial basis for making instream flow recommendations in conjunction with information on pre-TRD hydrology, fluvial geomorphology (streamflows needed to form and maintain the channel), sediment management, and water temperatures.

Several channel rehabilitation projects were evaluated to determine if these projects created the shallow, low velocity habitats required by young salmon and steelhead for rearing. Results indicated that restoring the gradually sloping bars provided stable amounts of rearing habitat throughout a wide range of flows - an improvement over conditions in the existing channel where the amount of available habitat fluctuates widely over the same range of flows. Rehabilitating the confined, trapezoidal channel to restore the pre-TRD channel morphology will provide high quality, stable habitat conditions that should greatly benefit young salmon and steelhead until they are ready to migrate to the ocean.

TRD operations disrupted the water and sediment interactions of the river, which changed the fish habitats below Lewiston Dam. To rehabilitate the complex habitats that were similar to those that existed in the pre-TRD alluvial channel, pre- and post-TRD water and sediment interactions were examined to determine what pre-TRD processes are absent in the post-TRD river and how these processes can be re-established. These processes are largely defined by a set of ten fundamental alluvial river attributes. These attributes are: (1) the channel morphology is spatially complex; (2) flows and water quality are predictably variable; (3) the channel-bed surfaces are frequently mobilized; (4) the channel-bed surfaces are periodically scoured and refilled; (5) fine and coarse sediment supplies are approximately balanced in the upper Trinity River below Lewiston Dam ; (6) the channel location periodically migrates; (7) the channel has a functional floodplain; (8) the channel is occasionally "reset" during very large floods; (9) riparian plant communities are diverse and self-sustaining; and (10) the groundwater table (subsurface water level that surrounds rock, gravel and sand along the side of the river) fluctuates naturally with changing streamflows. Studies were conducted to identify dam releases required to re-establish the processes necessary to achieve many of these attributes (called fluvial geomorphological processes). Recovering the dynamic alluvial channel morphology similar to that which existed pre-TRD will restore the diverse habitats needed by the fish and wildlife.

Water temperature affects every aspect of the life of salmonids, including egg incubation, growth, maturation, competition, migration, spawning, and resistance to parasites, diseases, and pollutants. Operations of the TRD changed the thermal regime of the Trinity River, providing warmer water temperatures during the winter and colder water temperatures at Lewiston during the late spring/summer than were present at Lewiston prior to the TRD because water is released from the deep levels behind the dam. It was generally believed that the TRD would increase salmonid production due to more stable flows and cooler summer water temperatures provided by dam releases. This increased production was never realized. Most salmonid smolts outmigrated before summer water temperatures were unsuitable. Rearing juvenile salmonids remained in the cooler riverine habitats above Lewiston that were predominantly fed by snowmelt, or sought the cool layer of water at the base of pools throughout the mainstem (a stratified pool). Operation and construction of the TRD blocked these upstream habitats and altered flows such that pools no longer stratify. Temperature objectives were established for the Trinity River that are, in effect, to compensate for the loss of these necessary cool-water habitats. In order to examine the dynamic relation between meteorology, tributary hydrology, dam release temperatures and release magnitudes that all influence downstream water temperatures, a temperature model (SNTEMP) was calibrated specifically for the Trinity River. This model was used to examine water temperatures under various conditions and to help determine what flows were necessary to meet temperature objectives for outmigrating salmon during the spring and early summer. Simulations and measured data show that water temperatures throughout the Trinity River are influenced by dam releases during the spring. Increasing dam releases during the spring and early summer can improve temperature conditions in the river that promote better growing conditions and increase survival for ocean bound, outmigrating juveniles. Because spring- and fall-run chinook salmon require cold water to survive and successfully spawn, but can no longer access cold-water areas above Lewiston Dam, there is a need to maintain a cold-water segment below Lewiston Dam. Dam releases can be effectively managed to provide holding areas that are the proper temperature for adult salmon and steelhead during the summer, fall, and winter.

A model, SALMOD, was developed to evaluate the effect of varying environmental conditions (flows, water temperature, habitat availability) on the number of naturally produced young-of-the-year chinook salmon in the Trinity River from Lewiston Dam downstream 25 miles. This model evaluated the potential numbers of fish (young-of-the-year chinook as an index) that could be produced under the four water volumes identified in the

1981 Secretarial Decision. In general, model results indicated that (1) habitat conditions in the current channel severely limit the salmonid production potential of the Trinity River and (2) increased rearing habitat is critical to restore and maintain salmonid populations.

Evaluation of the 1981 Secretarial Decision Volumes

The 1981 Secretarial Decision identified four volumes of water for evaluation: 140 thousand acre-feet (TAF), 220 TAF, 287 TAF, and 340 TAF. One acre-foot of water is the volume of water that would cover one acre to a depth of one foot (approximately 326,000 gallons - an average household uses between one-half and one acre-foot of water per year). Release schedules developed for each of the water volumes were assessed for their ability to meet criteria necessary to restore and maintain the fishery resources of the Trinity River: fish habitat requirements, summer/fall temperature criteria, smolt outmigration temperature requirements, and thresholds for geomorphological processes that create and maintain diverse fish habitats (alluvial river attributes). The flow releases from Lewiston Dam required to meet the criteria and accomplish specific objectives are described below:

1. Year-round releases of 300 cfs to provide suitable spawning and rearing habitat for salmon and steelhead within the existing channel;
2. Releases of 450 cfs from July 1 to October 14 to meet the summer/fall temperature objectives;
3. Spring/summer releases that would provide improved conditions for smolt outmigration; and
4. Releases necessary to achieve flow-related geomorphic processes that create and maintain river habitats.

The volumes of water identified in the 1981 Secretarial Decision were able to meet the fishery restoration criteria in varying degrees, although all criteria are not fully met even with the greatest volume, 340 TAF. The current water volume of 340 TAF is equal to the third driest year in the 84-year period of record at Lewiston, indicating that the river below Lewiston Dam has experienced a functional 35-year drought since TRD operations began. Habitat degradation and fine sedimentation, identified as reasons for the decline of these fishery resources, will continue under all 1981 Secretarial Decision volumes because of lack of sufficient water to address multiple needs within a single year. SALMOD results showed that peak production of chinook salmon will be reached at water volumes above those identified in the 1981 Secretarial Decision.

Fishery Restoration Strategy

The recommended strategy to rehabilitate salmonid habitat is a management approach that integrates riverine processes and instream flow-dependent needs. A fundamental conclusion of this and other studies is that the present channel morphology, a direct result of TRD construction and operation, is inadequate to meet salmonid production objectives. If naturally produced salmonid populations are to be restored and maintained, the habitats on which they depend must be rehabilitated.

Recommended future management to restore the fishery resources of the Trinity River must include reshaping selected channel segments, managing coarse and fine sediment input, prescribing reservoir releases to allow flow-related geomorphic processes to reshape and maintain a new dynamic channel condition, providing suitable spawning and rearing microhabitat, and providing favorable water temperatures for salmonids. This new channel morphology will be smaller in scale than that which existed pre-TRD, but it will exhibit the essential attributes of a dynamic alluvial river.

Recommendations

Rehabilitation of the mainstem Trinity River can best be achieved by restoring processes that provided abundant complex instream habitat prior to construction and operation of TRD. Restoring these processes requires releasing increased annual instream volumes in conjunction with variable reservoir release schedules, managing fine and coarse sediment supplies, and rehabilitating selected reaches of the mainstem channel. Studies per-

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formed as part of the TRFE identified three sets of flow-related management objectives: (1) releases to provide suitable salmonid spawning and rearing habitat, (2) releases to mimic the spring snowmelt hydrograph (the high flow in the spring resulting from the melting snowpack and the gradual decrease in flow following the peak) to satisfy flow-related geomorphic and riparian vegetation objectives necessary for the creation and maintenance of diverse salmonid habitats and assist smolt outmigration, and (3) releases to meet appropriate water-temperature objectives for holding/spawning adult salmonids and outmigrating salmonid smolts. Together, these recommended actions will rehabilitate the mainstem channel below Lewiston and provide the habitats necessary to restore and maintain the fishery resources of the Trinity River.

Water Year Classification and Annual Instream Water Volumes

Variability is a keystone to the restoration strategy because no single annual flow regime can be expected to perform all functions needed to maintain an alluvial river system and restore and maintain the fishery resources. There are five water-year classes used in this study to describe the variability expected from year to year. They are Critically Dry, Dry, Normal, Wet, and Extremely Wet. In the restoration strategy outlined in this report, various flow-related geomorphic objectives and desired habitat conditions (microhabitat and temperature objectives) are targeted for each water-year class. Some processes and habitat conditions, such as favorable spawning and rearing microhabitat, are recommended for all water-year classes while others, such as floodplain inundation, are expected to be achieved only during the wetter water-year classes. Annual release schedules were developed by integrating the information requirements to meet spawning and rearing microhabitat, flow-related geomorphic processes, and water temperature management objectives for the different water-year classes.

Inter-annual flow variability is achieved by recommending unique annual flow releases for each water year class. Recommended total instream water volumes range from 368.6 TAF in Critically Dry water years to 815.2 TAF in Extremely Wet water years (Table ES2). The average (weighted by water year class probability) water volume required for the Trinity River will be 594.5 TAF, an average increase of 254.5 TAF over the current water volume of 340 TAF.

Within Year (Seasonal) Flow Recommendations

Intra-annual changes in flow are often described by water managers, hydrologists and scientists by a seasonal hydrograph, usually expressed as average daily flows in cubic feet per second (cfs). Flow levels fluctuate throughout the year based on weather conditions or managed water releases. The following summary is a description of recommended water releases from Lewiston Dam and the expected benefits downstream from the dam. The described seasonal water releases of the total water volume assigned to each water-year class are graphically depicted in Figure ES1.

In the present Trinity River channel, maintaining 300 cfs as the fall/winter baseflow provides suitable spawning habitat throughout the chinook salmon, coho salmon, and steelhead spawning seasons and provides habitat for rearing salmon and steelhead.

Since flow-related geomorphic management objectives require various flow levels, more comprehensive changes occur during wetter years. A list of the expected objectives that can be met by releases during the spring snowmelt hydrograph in different water-year classes is depicted in Table ES3. The short, 5-day, peak release during all water-year classes (except Critically Dry) provides sufficient duration to initiate targeted flow-related geomorphic processes and transport coarse bed material originating from tributaries in most years. The timing of the spring snowmelt peak release varies on the basis of historical timing, with the peak occurring later during wetter water years. The magnitude of releases to achieve flow-related geomorphic processes targeted for each water-year class varies, ranging from 1,500 cfs in Critically Dry water years to 11,000 cfs in Extremely Wet water years. The recommended Extremely Wet and Wet spring snowmelt hydrographs also have two distinct segments while flows are decreasing after the spring snowmelt peak flow (referred to as the "descending limb of the spring snowmelt hydrograph"). These periods are separated by a short-duration "bench" at 6,000 cfs. The "bench" promotes transport of fine sediment once peak flows have mobilized the surface layer of the channelbed. Another "bench", at 2,000 cfs, is recommended for Extremely Wet, Wet, and Normal water years

Table ES2. Recommended annual water volumes for instream release to the Trinity River in thousands of acre-feet (TAF), probability of occurrence, and Trinity Reservoir inflow thresholds.

Water-Year Class	Instream Volume (TAF)	Trinity Reservoir Inflow (TAF)	Probability of Occurrence
Extremely Wet	815.2	>2,000	0.12
Wet	701.0	1,350 to 2,000	0.28
Normal	646.9	1,025 to 1,350	0.20
Dry	452.6	650 to 1,025	0.28
Critically Dry	368.6	<650	0.12
Average (weighted by water-year probability)	594.5		

to inundate portions of alternate bars during the time-period when riparian vegetation releases seeds. This inundation prevents riparian encroachment along the low-flow channel and provides suitable temperatures for chinook salmon smolts, which outmigrate later in the year than other salmonid species. A 36-day, 1,500-cfs "bench" during Critically Dry water years will discourage seedling germination on alternate bar flanks through inundation and provide some temperature benefits for outmigrating chinook salmon smolts. The rate of change for the descending limbs of the snowmelt hydrographs mimics natural receding snowmelt hydrograph rates.

Because of the long outmigration period for the three salmonid species combined, a variety of outmigrant temperature conditions are necessary throughout the spring/summer hydrographs. Recommended releases for Extremely Wet, Wet, and Normal water years provide optimal salmonid smolt temperatures (Table ES4). Marginal smolt temperatures will be provided throughout much of the outmigration period during Dry and Critically Dry water years. The lower releases during these year classes will allow mainstem water temperatures to warm earlier in the outmigration period, which will cue salmonids to outmigrate (warming temperatures are an important physiological signal to begin smoltification and outmigration) before water temperatures in the lower watershed are likely to become too warm to insure smolt survival. Following smolt temperature control releases, 450 cfs releases will be maintained to provide suitable temperature regimes for holding and spawning adult spring-run and fall-run chinook (Table ES5).

Channel Rehabilitation

Channel-rehabilitation activities are recommended along the mainstem Trinity River from Lewiston Dam to the North Fork Trinity River confluence. The intent of channel rehabilitation is to selectively remove the fossilized riparian berms (berms that have been anchored by extensive woody vegetation root systems and consolidated sand deposits) and recreate alternate bars. Channel rehabilitation is not intended to completely remove all riparian vegetation, but to remove vegetation at strategic locations to promote alluvial processes necessary for the restoration and maintenance of salmonid populations. The tightly bound berm material is hard to mobilize even at high flows, and mechanical berm removal is necessary. After selected berm removal, subsequent high-flow releases and coarse sediment supplementation will maintain these alternate bars and create a new dynamic channel. Specific channel rehabilitation recommendations vary by river segment between Lewiston Dam to the confluence of the North Fork Trinity River because the needs of channel rehabilitation change with tributary inputs of flow and sediment.

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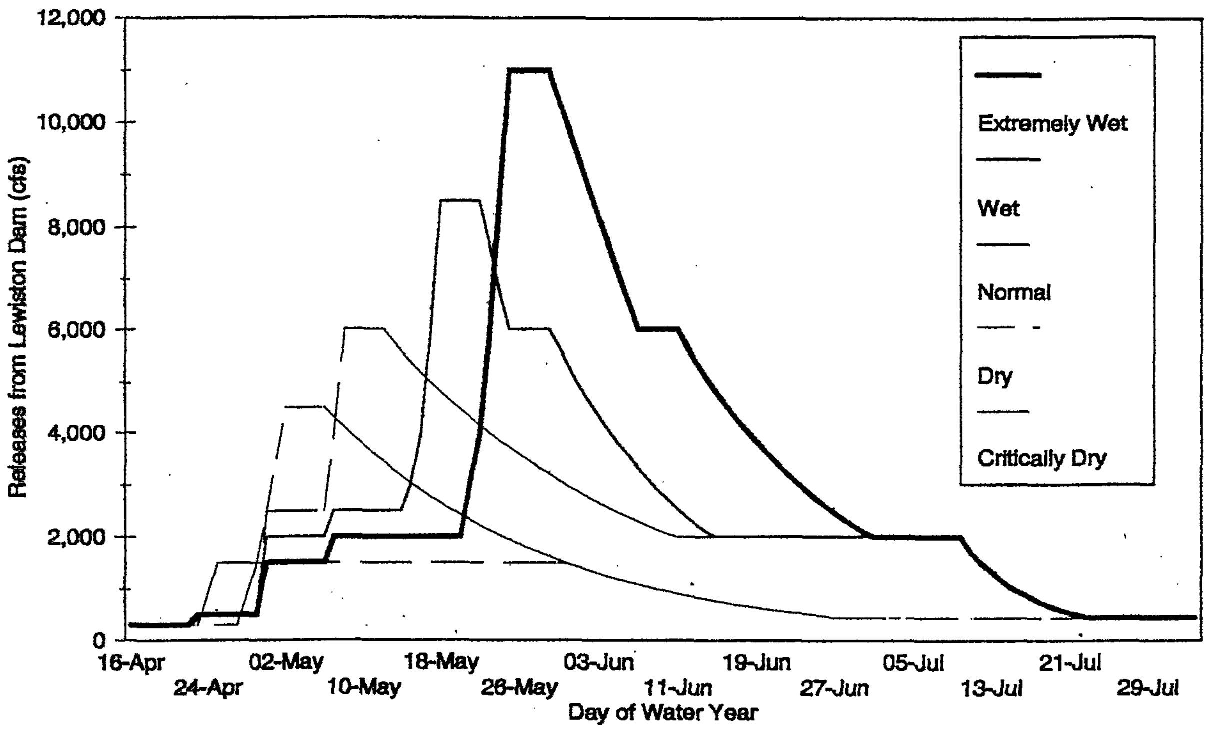

Figure ES1. Trinity River Flow Evaluation annual recommended hydrographs for each water year class: Extremely Wet, Wet, Normal, Dry, and Critically Dry. For all hydrographs, the recommended release from Lewiston Dam is 300 cfs from October 16 to April 8 and 450 cfs from August 1 to October 14.

The Service and Hoopa Valley Tribe identified 44 potential channel-rehabilitation sites, 3 potential side channel-rehabilitation sites, and 2 tributary delta maintenance sites. These sites are located where channel morphology, sediment supply, and high-flow hydraulics would encourage a dynamic, alluvial channel. A short implementation period for a significant number of these projects is recommended to evaluate whether they achieve their intended benefits: increasing the quality and quantity of salmonid habitat. Therefore, construction of 24 of the 44 channel-rehabilitation sites in the first 3 years of implementation is recommended. The remaining projects may proceed following evaluation by the AEAM program (see section on the AEAM program below).

Sediment Management

Sediment-management recommendations include (1) immediate placement of more than 16,000 cubic yards of properly graded coarse sediment ($^5/_{16}$ to 5 inches) between Lewiston Dam and Rush Creek to restore the spawning gravel deficit caused by the elimination of upstream coarse sediment supply by the TRD; (2) annual supplementation of coarse sediment to balance the coarse sediment supply along the Lewiston Dam to Rush Creek segment; (3) reduction of fine sediment (< $^5/_{16}$ inch) storage in the mainstem via recommended flow releases; (4) prevention of fine sediment input from tributaries by mechanical removal from sedimentation ponds; and (5) reduction of fine sediment storage in the mainstem via mechanical removal. Channel-rehabilitation efforts will also remove large quantities (potentially up to 1 million cubic yards) of fine sediment stored in the riparian berms between Lewiston Dam and the North Fork Trinity River confluence.

Table ES3. Flow related geomorphic peak releases and durations with associated water-year classes and management objectives.

Peak Release (cfs)	Duration (days)	Water-Year Class	Management Objectives Achieved Through Flow Related Geomorphic Processes
1,500	36	Crit. Dry	• Prevention of germination/establishment of riparian vegetation low on alternate bars
4,500	5	Dry	• Mobilization of spawning gravels • Sand transport • All effects realized at lower flow level
6,000	5	Normal	• Channelbed surface mobilization • Significant mobilization of spawning gravels • Fine sediment movement • Channel migration • Floodplain inundation • Scour of 1-2 year old seedlings • Groundwater recharge of floodplain • All effects realized at lower flow levels
8,500	5	Wet	• Surface mobilization of alternate bars • Scour of bar margins • Coarse sediment movement • Scour of 2-3 year old seedlings • All effects realized at lower flow levels
11,000	5	Ext. Wet	• Significant scour of alternate bars • Large coarse sediment movement • Floodplain scour • Side-channel formation/maintenance • Sapling removal from alternate bars • All effects realized at lower flow levels

Table ES4. Water temperature objectives for the Trinity River salmonid smolts at the confluence of the Klamath and Trinity rivers for Extremely Wet, Wet, and Normal water year classes. These objectives are not met in Dry and Critically Dry water year classes because of the need to better synchronize Trinity River temperatures with those lower in the system.

Species	Temperature	Target Date
Steelhead	< 55.4°F	May 22
Coho Salmon	< 59°F	June 4
Chinook Salmon	< 62.6°F	July 9

Table ES5. Water temperature objectives for the Trinity River during the summer, fall, and winter. Objectives are for the protection of holding and spawning salmon and steelhead.

	Temperature Objective Control Point	
Date	Douglas City (RM 92.2)	North Fork Trinity River (RM 72.4)
July 1 - September 14	60°F	-
September 15 - September 30	56°F	-
October 1 - December 31	-	56°F

Adaptive Environmental Assessment and Management Program

The Trinity River Flow Evaluation Report, and the recommendations contained herein, are based on the best available scientific information compiled by a diverse group of scientists and engineers from various Federal, Tribal, and State agencies, and have been peer reviewed by outside experts and affected interests. Alluvial river systems are complex and dynamic. While our understanding of these systems and our predictive capabilities are extensive, some uncertainty over how the river and the fishery resources will react to the proposed recommendations still exists. Nonetheless, resource managers must make decisions and implement plans despite these uncertainties. AEAM provides a structured mechanism for fine-tuning management recommendations in relation to the recommended flows, sediment management, and channel rehabilitation activities.

Establishing an AEAM process for the Trinity River is recommended to guide future restoration activities. The proposed AEAM is an iterative 10-step process:

(1) Refine ecosystem goals and objectives;

(2) Monitor and assess the ecosystem baseline;.

(3) Hypothesize biological/physical system behavior/response;

(4) Select future management actions;

(5) Implement management actions;

(6) Monitor the ecosystem response;

(7) Compare predictions with ecosystem response;

(8) Restate the ecosystem status;

(9) Use the adaptive process to evolve understanding of the ecosystem; and

(10) Assess continuing, modifying, or taking new actions.

Use of AEAM will assure restoration and maintenance of the fishery resources of the Trinity River and wise use of available water.

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